

(12)

(21) **2 311 386**

(51) Int. Cl.⁸: **A61L 002/10**

(22) **24.11.1998**

(85) **24.05.2000**

(86) **PCT/US98/25053**

(87) **WO99/26668**

(30) **60/066,500 US 24.11.1997**
60/094,574 US 29.07.1998

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(54) **PROCEDE ET DISPOSITIF DE PURIFICATION DE REJETS D'APPAREIL ET DE DECONTAMINATION D'OBJETS**

(54) **METHOD AND APPARATUS FOR PURIFYING APPLIANCE EXHAUST AND REMOVING CONTAMINANTS FROM OBJECTS**

(57)

A method and apparatus for purifying appliance exhaust is accomplished by an air purification system in which an air stream is drawn into the system (2) and flows through an ozone chamber (8). The ozone chamber (8) includes an ozone generating radiation source (12) that irradiates the air stream to generate ozone which oxidizes contaminants residing in the air stream. Subsequent to traversing the ozone chamber (8), the air stream enters a germicidal chamber (16) having a germicidal radiation source (14) that irradiates the air stream and destroys bacteria and breaks down ozone residing therein. The system (2) is typically disposed in an air flow path within an appliance, such as a vacuum cleaner, to treat the air and return purified air to a surrounding environment. Further, the system (2) may be configured to remove contaminants from objects, such as food, using a porous receptacle (15) to support the object in the ozone chamber (8). Additionally, the system may be configured to remove contaminants from a user's hand.



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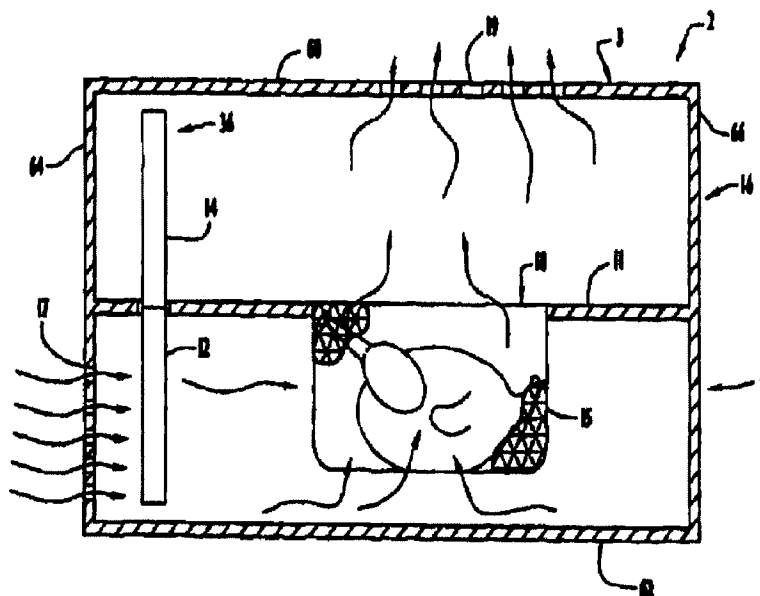
(51) Int. Cl.⁶ A61L 2/10

(30) 1997/11/24 (60/066,500) US

(30) 1998/07/29 (60/094,574) US

(54) **PROCEDE ET DISPOSITIF DE PURIFICATION DE REJETS
D'APPAREIL ET DE DECONTAMINATION D'OBJETS**

(54) **METHOD AND APPARATUS FOR PURIFYING APPLIANCE
EXHAUST AND REMOVING CONTAMINANTS FROM
OBJECTS**



(57) La présente invention concerne un procédé et un appareil servant à purifier les rejets d'un appareil. Ledit procédé est et mis en oeuvre par un système de purification d'air dans lequel un courant d'air aspiré par le système (2) traverse une chambre d'ozonisation (8). Cette chambre d'ozonisation (8) comporte une source de rayonnement (12) produisant de l'ozone qui vient irradier le courant d'air de façon à générer de l'ozone qui oxyde les contaminants en suspension dans le courant

(57) A method and apparatus for purifying appliance exhaust is accomplished by an air purification system in which an air stream is drawn into the system (2) and flows through an ozone chamber (8). The ozone chamber (8) includes an ozone generating radiation source (12) that irradiates the air stream to generate ozone which oxidizes contaminants residing in the air stream. Subsequent to traversing the ozone chamber (8), the air stream enters a germicidal chamber (16) having a





(21) (A1) **2,311,386**
(86) 1998/11/24
(87) 1999/06/03

d'air. Après la traversée de la chambre d'ozonisation (8), le courant d'air pénètre dans une chambre microbicide (16) dotée d'une source de rayonnement (14) microbicide qui irradie le courant d'air et détruit les bactéries ainsi que l'ozone résiduel dans ce courant d'air. Le système (2) se monte généralement dans le passage d'un courant d'air à l'intérieur d'un appareil tel qu'un aspirateur de ménage, de façon à traiter l'air et à restituer de l'air purifié à l'atmosphère ambiante. Le système (2) peut également être configuré pour décontaminer des objets, des aliments par exemple, placés dans un récipient poreux à l'intérieur de la chambre d'ozonisation (8). Par ailleurs, le système peut être configuré pour décontaminer les mains d'un utilisateur.

germicidal radiation source (14) that irradiates the air stream and destroys bacteria and breaks down ozone residing therein. The system (2) is typically disposed in an air flow path within an appliance, such as a vacuum cleaner, to treat the air and return purified air to a surrounding environment. Further, the system (2) may be configured to remove contaminants from objects, such as food, using a porous receptacle (15) to support the object in the ozone chamber (8). Additionally, the system may be configured to remove contaminants from a user's hand.



PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : A61L 2/10		A1	(11) International Publication Number: WO 99/26668
			(43) International Publication Date: 3 June 1999 (03.06.99)
(21) International Application Number: PCT/US98/25053 (22) International Filing Date: 24 November 1998 (24.11.98) (30) Priority Data: 60/066,500 24 November 1997 (24.11.97) US 60/094,574 29 July 1998 (29.07.98) US (71) Applicant (for all designated States except US): ECO-AIRE COMPANY, INC. [US/US]; 2051 N.E. 191 Drive, North Miami Beach, FL 33179 (US). (72) Inventor; and (75) Inventor/Applicant (for US only): NELSON, Jerry [US/US]; 68 Zachariah Place, Warwick, RI 02889 (US). (74) Agents: SHAPIRO, Stuart, B. et al.; Epstein, Edell & Retzer, Suite 400, 1901 Research Boulevard, Rockville, MD 20850-3164 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>	
(54) Title: METHOD AND APPARATUS FOR PURIFYING APPLIANCE EXHAUST AND REMOVING CONTAMINANTS FROM OBJECTS			
(57) Abstract A method and apparatus for purifying appliance exhaust is accomplished by an air purification system in which an air stream is drawn into the system (2) and flows through an ozone chamber (8). The ozone chamber (8) includes an ozone generating radiation source (12) that irradiates the air stream to generate ozone which oxidizes contaminants residing in the air stream. Subsequent to traversing the ozone chamber (8), the air stream enters a germicidal chamber (16) having a germicidal radiation source (14) that irradiates the air stream and destroys bacteria and breaks down ozone residing therein. The system (2) is typically disposed in an air flow path within an appliance, such as a vacuum cleaner, to treat the air and return purified air to a surrounding environment. Further, the system (2) may be configured to remove contaminants from objects, such as food, using a porous receptacle (15) to support the object in the ozone chamber (8). Additionally, the system may be configured to remove contaminants from a user's hand.			

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**METHOD AND APPARATUS FOR PURIFYING APPLIANCE
EXHAUST AND REMOVING CONTAMINANTS FROM OBJECTS**

CROSS-REFERENCE TO RELATED APPLICATIONS

1
2 This application is a continuation-in-part of copending U.S. Patent Application
3 Serial No. 09/186,990, entitled "Method And Apparatus For Producing Purified Or
4 Ozone Enriched Air To Remove Contaminants From Fluids", filed November 5, 1998,
5 which is a continuation-in-part of U.S. Patent Application Serial No. 09/156,422, entitled
6 "Method and Apparatus for Producing Purified or Ozone Enriched Air", filed September
7 18, 1998, which is a continuation-in-part of U.S. Patent Application Serial No.
8 08/932,101, entitled "Method and Apparatus for Removing Contaminants from a
9 Contaminated Air Stream", filed on September 17, 1997. In addition, this application
10 claims priority from U.S. Provisional Patent Application Serial No. 60/066,500, entitled
11 "Method and Apparatus for Purifying Appliance Exhaust and Removing Contaminants
12 from Objects", filed on November 24, 1997, and from U.S. Provisional Patent
13 Application Serial No. 60/094,574, entitled "Method and Apparatus for Producing
14 Purified or Ozone Enriched Air to Remove Contaminants from Objects", filed on July 29,
15 1998. The disclosures in the above-referenced patent applications are incorporated herein
16 by reference in their entireties.

BACKGROUND OF THE INVENTION

1. Technical Field

17
18
19 The present invention pertains to a method and apparatus for purifying an air
20 stream within an appliance prior to that air stream returning to a surrounding
21 environment. Further, the present invention pertains to a method and apparatus for
22 removing contaminants from objects. In particular, the present invention pertains to a
23 method and apparatus for exposing a contaminated air stream within an appliance,
24 preferably a vacuum cleaner, to ozone and germicidal radiation to remove contaminants

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1 from that air stream and return sterilized air to a surrounding environment. Moreover,
2 the present invention pertains to a method and apparatus for producing ozone enriched air
3 to remove contaminants from objects, such as food, hands, etc.

4 2. Discussion of Related Art

5 Currently, there are numerous devices known as deodorizing machines utilizing
6 ozone and/or ultraviolet (UV) radiation to sanitize and deodorize air in a treated space
7 (i.e., typically a room). Generally, these devices generate large amounts of ozone gas to
8 attain the ozone concentration level necessary to facilitate deodorizing and sterilizing the
9 air. Since ozone concentration levels required for sterilization are sufficiently high to be
10 dangerous to people and/or animals, the use of these devices is typically limited to odors
11 whose removal is difficult (e.g., smoke from fires, organic material spilled on clothing,
12 etc.). Further, when the devices are used in the proximity of people and/or animals,
13 health authorities require that ozone concentrations be reduced to safe levels. However,
14 these reduced or "safe" levels tend to be too low to effectively deodorize and clean the
15 air. Moreover, such devices typically use the germicidal qualities of the ultraviolet
16 radiation to destroy bacteria in the air, but generally either expose the treated space to
17 high levels of radiation, thereby posing health risks to people and/or animals, such as eye
18 trauma and skin lesions, or use very low levels of radiation requiring long exposure
19 times.

20 The prior art attempts to obviate the aforementioned problems by exposing air
21 from the treated space to ozone or UV radiation internally of a device to thereby shield
22 against the above-mentioned harmful effects. For example, Burt (U.S. Patent No.
23 3,486,308) discloses an air treatment device having a UV radiation source to sterilize air
24 and a plurality of baffles disposed within the interior of the device housing. The baffles
25 increase an air flow path within the device beyond the dimensions of the device housing
26 to expose the air to radiation for greater periods of time. The UV source produces
27 radiation at a particular intensity to avoid production of ozone.

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1 Japanese Publication JP 1-224030 discloses an air cleaner including an ozone
2 generating section, an ozone-air mixing section and a filter section. The filter section
3 may include a pair of filters having an alkaline component and ozone-purifying material,
4 respectively. Alternatively, the filter section may include a single filter having both an
5 alkaline component and ozone-purifying material to clean air. The air cleaner further
6 includes a winding air flow path for the air stream to traverse during cleaning.

7 The prior art devices disclosed in the Burt patent and Japanese Publication suffer
8 from several disadvantages. In particular, the Burt device does not utilize ozone, thereby
9 typically only removing bacterial contaminants (e.g., germs) within an air stream and
10 enabling non-bacterial or other contaminants, such as odor causing contaminants, to be
11 returned to a surrounding environment. Conversely, the air cleaner disclosed in the
12 Japanese Publication employs only ozone to clean the air, thereby possibly destroying
13 only a portion of bacterial contaminants within the air stream, while returning residual
14 bacterial contaminants to a surrounding environment.

15 The prior art attempted to overcome the above mentioned disadvantages by
16 employing ozone in combination with UV radiation to remove virtually all contaminants
17 from an air stream. In particular, Chesney (U.S. Patent No. 2,150,263) discloses a
18 system for internally cleaning, sterilizing and conditioning air within the system. A
19 stream of air is washed and subsequently exposed to UV radiation which generates ozone
20 such that the combination of UV radiation and ozone destroys virtually all bacteria in the
21 air stream. Excess ozone is removed via pumps and utilized for various purposes.

22 Hirai (U.S. Patent No. 5,015,442) discloses an air sterilizing and deodorizing
23 system wherein UV radiation generates ozone to oxidize and decompose odor-causing
24 components in the air. The ozone is then removed by a catalyzer in conjunction with,
25 and prior to, germicidal UV radiation where the UV radiation also removes germs and
26 sterilizes the air.

27 Monagan (U.S. Patent No. 5,601,786) discloses an air purifier including a housing
28 having an irradiation chamber, an air inlet for directing air into the irradiation chamber, a
29 radiation source disposed within the irradiation chamber and an air outlet formed in the

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1 housing for discharging air to the environment. The radiation source preferably emits
2 ozone-producing radiation within one wavelength interval, and germicidal radiation
3 within another wavelength interval, whereby the emitted radiation serves to destroy
4 microorganisms and deodorize the air.

5 LeVay et al (U.S. Patent No. 5,614,151) discloses an electrodeless sterilizer using
6 ultraviolet radiation and/or ozone. The sterilizer includes an energy source to excite a gas
7 contained within a bulb and produce ultraviolet radiation, preferably strongest at 253.7
8 nanometers, that may be utilized to sanitize substances. Further, the radiation may be
9 used to generate ozone that, either alone or in combination with the radiation, may
10 sanitize substances. The bulb may be shaped to enable substances (e.g., liquid) to pass
11 through the bulb for sterilization, or to enclose and shield objects (e.g., small articles)
12 within the bulb from the energy source. Moreover, the bulb may be located at the end of
13 a waveguide, or radiation may be transmitted from the bulb via an optic feed to sanitize
14 inaccessible surfaces of substances. In addition, an ozone generator may be utilized to
15 apply ozone to an external substance, whereby flexible hosing connected to the ozone
16 generator includes a nozzle to control discharge of ozone onto a substance.

17 The Chesney, Hirai, Monagan and LeVay et al systems suffer from several
18 disadvantages. Specifically, the Chesney and LeVay et al systems typically utilize a
19 single wavelength of UV radiation (e.g., approximately 254 nanometers) which may not
20 be optimal for both generating ozone and destroying bacteria. In fact, this wavelength is
21 generally utilized for its germicidal effects and tends to destroy ozone, thereby degrading
22 the effect of ozone within the air stream. Although the Monagan system utilizes a
23 radiation source emitting ozone-producing and germicidal radiation, an air stream is
24 exposed to each type of radiation simultaneously, thereby enabling the germicidal
25 radiation to destroy produced ozone and degrade the effect of ozone within the air stream.
26 Further, the Chesney system includes a relatively lengthy compartment for treating air,
27 thereby increasing the size and cost of the system. The Hirai system typically utilizes
28 independent radiation sources to generate ozone and germicidal radiation, thereby
29 increasing system cost and complexity. Moreover, the Hirai system does not provide a

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1 safety feature where the ozone generating source may be operable when the germicidal or
2 ozone removing source becomes inoperable, thereby leading to emissions of dangerous
3 ozone concentrations from the system. In addition, the Hirai system employs a relatively
4 short, narrow area for ozone generation, while the Monagan system includes a radiation
5 source having adjacent portions emitting ozone generating and germicidal radiation, and
6 a substantially linear path disposed within an irradiation chamber for an air stream to
7 traverse the radiation source. Thus, the effects of ozone within an air stream in the Hirai
8 and Monagan systems are degraded since there is generally a minimal amount of time
9 and/or space for the ozone to interact with the air prior to exposure to germicidal
10 radiation.

11 Although the LeVay et al system may sanitize substances via ozone and
12 ultraviolet radiation, the ozone is typically generated by a single wavelength of radiation
13 (e.g., approximately 254 nanometers) that tends to destroy ozone as described above,
14 thereby minimizing the effects of ozone on the substance. Further, the LeVay et al
15 system sanitizes a liquid substance by introducing ozone into the liquid subsequent to
16 exposure of that liquid to germicidal radiation, thereby enabling the liquid to contain
17 ozone concentration levels sufficient to cause possible harm to people and/or animals that
18 contact the treated liquid. The LeVay et al patent further discloses systems for applying
19 ultraviolet radiation or ozone to surfaces of substances external of those systems. The
20 radiation may be applied to the external substance via a light pipe or optic feed, while
21 ozone may be applied via a nozzle disposed at an end of flexible hosing attached to an
22 ozone generator. However, these devices may not fully expose the substance surfaces to
23 the ultraviolet radiation or ozone, thereby incompletely sanitizing the substance.
24 Moreover, the ultraviolet radiation or ozone is applied to the substance surfaces typically
25 without preventive or containment measures, thereby enabling radiation and ozone to be
26 released to the surrounding environment and cause possible harm to people and/or
27 animals in the vicinity of the substance as described above.

28

OBJECTS AND SUMMARY OF THE INVENTION

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1 Accordingly, it is an object of the present invention to expose air streams within
2 appliances to ozone and germicidal radiation to remove contaminants from those air
3 streams and return purified air to a surrounding environment.

4 It is another object of the present invention to maintain ozone concentration levels
5 at low or "safe" levels in a contaminant removal system by utilizing a single radiation
6 source within the system to emit ozone generating and germicidal radiation of different
7 wavelengths from different sections of the source to generate ozone within and to
8 perform germicidal functions on an air stream residing in the system. The entire single
9 radiation source can become disabled only as a unit, thereby preventing generation of
10 ozone when the germicidal radiation or ozone-removing section is inoperable.

11 Yet another object of the present invention is to utilize ozone, either alone or in
12 combination with germicidal radiation, to remove contaminants from objects (e.g., food
13 items, hands, etc.).

14 The aforesaid objects are achieved individually and in combination, and it is not
15 intended that the present invention be construed as requiring two or more of the objects
16 to be combined unless expressly required by the claims attached hereto.

17 According to the present invention, a method and apparatus for purifying
18 appliance exhaust is accomplished by an air purification system in which air is drawn in
19 as a stream into the system housing and flows through an ozone generating chamber. An
20 ozone generating ultraviolet (UV) radiation source disposed within the ozone chamber
21 emits ultraviolet radiation having a wavelength of approximately 185 nanometers to
22 irradiate the air and generate ozone which oxidizes contaminants (e.g., bacteria, virus,
23 odor-causing element, etc.) residing in the air stream. The ozone chamber is typically
24 configured to include winding or other types of air flow paths, or to induce a vortical air
25 flow, to reduce air through-flow velocity and maintain the air stream within the ozone
26 chamber for a residence time sufficient for the ozone to interact with the air. Subsequent
27 to traversing the ozone chamber, the air stream enters a germicidal chamber disposed
28 adjacent the ozone chamber. The germicidal chamber may also be configured to have
29 winding or other types of air flow paths, and includes a germicidal UV radiation source.

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1 The germicidal UV radiation source irradiates the air stream and destroys bacteria and
2 breaks down ozone residing therein. The germicidal UV radiation source generates
3 radiation having a wavelength of approximately 254 nanometers to destroy bacteria,
4 viruses, mold spores and ozone remaining after the interaction of air and ozone in the
5 ozone chamber. The radiation source typically includes a single combination UV
6 radiation emitting bulb with different sections of the bulb emitting radiation of different
7 respective wavelengths (e.g., 185 and 254 nanometers). The different sections of the
8 bulb are disposed in the corresponding ozone and germicidal chambers. Alternatively,
9 the radiation source may be implemented by separate independent bulbs emitting
10 radiation having wavelengths of approximately 185 or 254 nanometers depending upon
11 the chamber in which the bulb is disposed.

12 The resulting sterilized air from the germicidal chamber may pass through a
13 catalytic converter disposed adjacent the germicidal chamber to remove any remaining
14 ozone by either converting the ozone back to oxygen, or filtering the ozone from the air
15 stream. An internal fan disposed adjacent the ozone chamber draws air into the system
16 and through the chambers. The system is typically disposed in an air flow path within an
17 appliance, such as a vacuum cleaner, to treat the air and return purified air to a
18 surrounding environment.

19 Further, the system may be configured to remove contaminants from objects, such
20 as food. Specifically, the system for removing contaminants from objects is similar to
21 the air purification system described above, and includes a combination radiation source
22 to provide ozone generating and germicidal radiation within the respective ozone and
23 germicidal chambers. The ozone chamber includes a porous receptacle for supporting an
24 object within the ozone chamber and enabling produced ozone within that chamber to
25 interact with and remove contaminants from the object. The ozonated air stream from the
26 ozone chamber flows through the porous receptacle and into the germicidal chamber,
27 wherein the air stream is exposed to germicidal radiation to remove residual
28 contaminants and ozone therefrom. The resulting sterilized air is returned to the
29 surrounding environment.

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1 In addition, the system may be configured to remove contaminants from a user's
2 hands. In particular, the system for removing contaminants from a user's hands is similar
3 to the air purification system described above, except that the system includes a single
4 treatment chamber having independent ozone generating and germicidal radiation
5 sources. The hands are inserted into the treatment chamber, whereby each radiation
6 source is enabled for a predetermined time interval. The ozone generating radiation
7 source initially generates ozone within the treatment chamber to remove contaminants
8 from the user's hands, while the germicidal radiation source is subsequently enabled to
9 expose those hands to germicidal radiation to remove residual contaminants and ozone
10 therefrom.

11 The above and still further objects, features and advantages of the present
12 invention will become apparent upon consideration of the following detailed description
13 of specific embodiments thereof, particularly when taken in conjunction with the
14 accompanying drawings wherein like reference numerals in the various figures are
15 utilized to designate like components.

16 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view in elevation and partial section of a portion of an exemplary system of the type employed by the present invention to produce purified or ozone enriched air.

Fig. 2 is a view in elevation and partial section of a system utilizing ozone enriched air to remove contaminants from various objects according to the present invention.

Fig. 3 is an exploded view in perspective and partial section of a system utilizing ozone and germicidal radiation to remove contaminants from a user's hands according to the present invention.

26 Fig. 4 is a side view in elevation and partial section of the system of Fig. 3.

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1 Fig. 5 is a side view in elevation and partial section of an upright vacuum cleaner
2 having a system to purify an air stream within the vacuum cleaner prior to that air stream
3 returning to a surrounding environment according to the present invention.

4 Fig. 6 is a side view in elevation of an alternative type of vacuum cleaner having a
5 system to purify an air stream within the vacuum cleaner prior to that air stream returning
6 to a surrounding environment according to the present invention.

7 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

8 An exemplary system of the type disclosed in the aforementioned patent
9 applications for removing contaminants from a contaminated air stream to produce
10 purified and/or ozone enriched air is illustrated in Fig. 1. Specifically, the system
11 includes a housing 5, ozone and germicidal chambers 8, 16, an ultraviolet (UV) radiation
12 source 36, typically implemented by a combination ultraviolet radiation emitting bulb
13 and disposed toward the approximate center of the ozone and germicidal chambers, a
14 ballast (not shown), preferably conventional, for supplying current to radiation source 36,
15 and an internal fan (not shown) for drawing air through the system. The radiation source
16 may be implemented by a single bulb having an ozone section 12 and germicidal section
17 14 emitting radiation at different wavelengths (e.g., 185 and 254 nanometers) from the
18 ozone and germicidal sections as disclosed in the above-referenced patent applications.
19 Alternatively, the radiation source may be implemented by independent bulbs disposed in
20 the respective ozone and germicidal chambers, whereby the bulb disposed in the ozone
21 chamber emits ozone generating radiation (e.g., having a wavelength of approximately
22 185 nanometers), while the bulb disposed in the germicidal chamber emits germicidal
23 radiation (e.g., having a wavelength of approximately 254 nanometers).

24 Air from a surrounding environment is drawn into the system through an air
25 intake (not shown) via the internal fan (not shown) and is directed by the internal fan and
26 the housing internal structure to flow into ozone chamber 8, typically disposed above and
27 adjacent the internal fan and air intake. Ozone chamber 8 includes ozone section 12 of
28 radiation source 36 and a tortuous or serpentine path 10 that serves to decrease air

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1 through-flow velocity (i.e., the path increases residence time of an air stream within the
2 ozone chamber, thereby decreasing velocity of the air stream through the chamber) and
3 enhance ozone distribution within the air stream in substantially the same manner
4 described in the above-referenced patent applications. Path 10 receives an air stream
5 entering ozone chamber 8 from the approximate bottom center of the ozone chamber
6 proximate ozone section 12, and transversely directs the air stream away from ozone
7 section 12 toward the system housing through successive passageways that alternate the
8 direction of air stream flow within the ozone chamber. It is to be understood that the
9 terms "top", "bottom", "upper", "lower", "front", "rear", "back", "side", "horizontal",
10 "vertical" and "length" are used herein merely to facilitate descriptions of points of
11 reference and do not limit the present invention to any specific configuration or
12 orientation. Ozone section 12 emits ozone generating radiation to produce ozone within
13 the air stream, while path 10 reduces air through-flow velocity and enables the produced
14 ozone to mix and interact with the air stream to oxidize contaminants. Once the air
15 stream traverses path 10, the air stream exits the ozone chamber and enters germicidal
16 chamber 16. Germicidal chamber 16 includes germicidal section 14 of radiation source
17 36 that emits germicidal UV radiation to destroy contaminants and ozone within the air
18 stream. The sterilized air from the germicidal chamber is exhausted from the system to
19 the surrounding environment. The system ozone and germicidal chambers may each
20 include various configurations as disclosed in the aforementioned patent applications.
21 For example, the ozone chamber may include any of the configurations disclosed in the
22 above-mentioned patent applications to reduce air through-flow velocity and enhance
23 distribution of ozone within the air stream.

24 Ozone enriched air may be produced and utilized by a system to remove
25 contaminants from various objects, such as food (e.g., meat, chicken, produce, etc.),
26 kitchen utensils (e.g., cutting boards, knives, forks, etc.) or other instruments. These
27 items may contain various microbes, such as E-coli or salmonella, that may cause illness.
28 An exemplary system for removing contaminants from food or other objects is illustrated
29 in Fig. 2. Specifically, system 2 includes a housing 3, ozone and germicidal chambers 8,

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1 16 as described above, radiation source 36, preferably having ozone section 12 and
2 germicidal section 14 as described above, a chamber divider 11 and a receptacle 15.
3 Housing 3 typically includes top and bottom walls 60, 62, front and rear walls (not
4 shown), and side walls 64, 66 that are each substantially rectangular and collectively
5 define the system interior. Divider 11 is substantially similar to the housing top and
6 bottom walls, and is disposed toward the approximate centers of the housing front, rear
7 and side walls. The divider extends across the system interior to separate and isolate the
8 ozone and germicidal chambers. Radiation source 36 is disposed toward system side
9 wall 64 and through divider 11 to position ozone section 12 and germicidal section 14 in
10 the ozone and germicidal chambers, respectively. Divider 11 includes an opening 18
11 defined toward the approximate center of the divider to enable an air stream to flow from
12 ozone chamber 8 into germicidal chamber 16. However, opening 18 may be defined at
13 any location along the divider. Receptacle 15 is typically constructed of mesh netting or
14 any other type of porous material to retain food or other objects within the receptacle,
15 whereby the porous material is attached to divider 11 toward the periphery of opening 18
16 to suspend the receptacle within the ozone chamber. The receptacle is disposed
17 proximate opening 18 such that an air stream from ozone chamber 8 is directed to flow
18 through the receptacle in order to enter germicidal chamber 16.

19 An air stream from a surrounding environment enters system 2 via slots 17,
20 typically defined within the bottom portion of system side wall 64 adjacent radiation
21 source 36. Slots 17 may be of any quantity (e.g., at least one), shape or size and may be
22 defined and arranged in side wall 64 in any fashion. The air stream may be drawn into
23 and through the system via an internal fan (not shown) as described above, while ozone
24 section 12 emits ozone generating radiation within ozone chamber 8 to generate ozone
25 within the air stream. Since the air stream is directed to traverse receptacle 15 and
26 opening 18, the air stream velocity through the ozone chamber is reduced, thereby
27 enabling the generated ozone to mix and interact with the air stream to remove
28 contaminants from the air stream. When the ozone enriched air flows through receptacle
29 15 in order to traverse opening 18, the object contained within the receptacle becomes

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1 soaked with the ozone enriched air, thereby enabling the ozone to remove contaminants
2 from the object. After traversing receptacle 15 and opening 18, the air stream enters
3 germicidal chamber 16 wherein germicidal section 14 of radiation source 36 exposes the
4 air stream to germicidal radiation to remove contaminants and ozone from the air stream.
5 The purified air stream is subsequently returned to the surrounding environment via slots
6 19, typically defined within top wall 60 or upper portions of side walls 64, 66. Slots 19
7 may be of any quantity (e.g., at least one), shape or size, and may be defined and
8 arranged in any fashion in the top or side walls, or any combination of those walls.

9 A further application for purified and/or ozone enriched air is to remove
10 contaminants from hands, especially hands of employees of restaurants or other food
11 service establishments. A system for removing contaminants from hands utilizing ozone
12 and germicidal radiation is illustrated in Figs. 3 - 4. Specifically, system 20 has a
13 configuration similar to the systems described above and includes a treatment chamber
14 23 having an ozone generating radiation source 22 and a germicidal radiation source 62.
15 The system includes top and bottom walls 70, 72, front and rear walls 74, 76 and side
16 walls 78, 80 that form a box-like housing 3. The walls are each substantially rectangular
17 and collectively define a system interior. Openings 24 are defined in housing front wall
18 74 for placement and removal of hands 26 within the system. A person typically inserts
19 his/her hands through openings 24 into the system treatment chamber for a short time
20 interval to enable ozone and germicidal radiation to remove any contaminants from the
21 hands in substantially the same manner described above. Openings 24 generally include
22 flaps 25 that form a seal with hands 26 to enable entry and removal of hands 26 within
23 treatment chamber 23, while preventing ozone from escaping the system.

24 Radiation sources 22, 62 are generally disposed in the upper portion of the system
25 substantially in parallel to each other, and extend between system side walls 78, 80. A
26 fan 27 is disposed near an air intake (not shown) and ozone radiation source 22 to direct
27 incoming air toward that source to generate ozone. A soaking chamber 21 is disposed
28 adjacent ozone radiation source 22 to enable generated ozone to mix and interact with the
29 air. In particular, a divider 82 extends from an intermediate portion of system top wall 70

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1 into the system interior to isolate the ozone generating radiation source and soaking
2 chamber from the germicidal radiation source. Dividers 84, 86 extend between housing
3 rear wall 76 and divider 82 to define and isolate the confines of the soaking chamber.
4 Divider 84 is disposed adjacent radiation source 22, while divider 86 extends from the
5 terminal portion of divider 82 toward the intermediate portion of rear wall 76. The
6 soaking chamber typically includes a winding or other type of path 10 to enhance
7 distribution of ozone within the air stream as described above. The path is formed by a
8 series of interleaved dividers 88, 90 directing the air stream in a serpentine fashion.
9 Specifically, dividers 88 each extend from divider 82 toward rear wall 76. The length of
10 each divider 88 is less than the distance between rear wall 76 and divider 82 to form
11 respective gaps between dividers 88 and the rear wall. Similarly, divider 90 extends from
12 rear wall 76 toward divider 82. The length of divider 90 is less than the distance between
13 rear wall 76 and divider 82 to form a gap between divider 90 and divider 82. Divider 90
14 is disposed between dividers 88 to form successive passageways collectively defining
15 serpentine path 10, whereby the gaps enable air to traverse succeeding passageways. An
16 opening 92 is defined in divider 84 toward divider 82, while an opening 96 is defined in
17 divider 86 toward rear wall 76. Openings 92, 96 enable the air stream to traverse path 10
18 and treat hands 26 residing within the treatment chamber. The ozone flows with the air
19 stream toward hands 26 inserted within the system treatment chamber near the treatment
20 chamber floor to oxidize and remove contaminants from the hands in substantially the
21 same manner described above. Subsequently, hands 26 are exposed to germicidal
22 radiation from germicidal radiation source 62 for a short time interval to remove bacteria
23 and ozone from the hands in substantially the same manner described above.

24 The system may include a microprocessor or other control circuitry to initiate
25 power to fan 27 and ozone radiation source 22 for a predetermined time interval to enable
26 generation of ozone and oxidation of contaminants as described above. Upon expiration
27 of the predetermined interval, power is disabled to fan 27 and ozone radiation source 22
28 to prevent ozone generation. The ozone concentration may thus be controlled based on
29 the length of this interval. Germicidal radiation source 62 is initiated subsequent to

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1 expiration of the ozone generation interval to expose hands 26 to germicidal radiation to
2 remove bacteria and ozone from the hands as described above. The germicidal radiation
3 source is similarly activated for a predetermined time interval, and then disabled to
4 permit removal of hands 26 from the system. An alarm or other indicator may be
5 disposed on the system to indicate completion of the treatment. The ozone generation
6 and germicidal intervals and other parameters may be programmed into the system via a
7 control panel (not shown).

8 The systems described above may be adapted to be of any size or shape and
9 include D.C. ballasts for powering the radiation sources in order to be transportable
10 and/or utilized in various vehicles (e.g., cars, boats, trucks, buses, trains etc.) or other
11 areas. The D.C. ballasts may receive power from conventional batteries or cigarette
12 lighters to enable the systems to be utilized at various remote locations. For example, the
13 food sterilization system may be transportable for removing contaminants from food at
14 picnics, barbecues or any other indoor or outdoor gatherings, while the hand system may
15 similarly be transportable to facilitate cleaning of hands at virtually any location.

16 The generation of ozone enriched and/or purified air may be utilized for various
17 other applications. For example, the systems described above and disclosed in the
18 aforementioned patent applications may be employed within various appliances, such as
19 vacuum cleaners, to purify air streams within these appliances prior to the air streams
20 returning to a surrounding environment as illustrated in Fig. 5. Specifically, a
21 conventional upright vacuum cleaner 30 generally includes a base or head 38, typically
22 housing a motor (not shown) and a substantially cylindrical brush assembly 39, a handle
23 32 and a bag 34 attached to handle 32 for collecting particles removed from a carpet or
24 floor by the vacuum cleaner. Bag 34 is typically a hard bag, commonly utilized with
25 vacuum cleaners, that includes top, bottom, front, rear and side walls to collectively
26 define a bag interior, and a collection chamber (not shown) to collect particles within the
27 bag. The vacuum cleaner motor draws air into head 38 via an inlet 37 disposed toward
28 the front bottom portion of the head. Brush assembly 39 is disposed within inlet 37 and
29 includes brushes disposed on its exterior surface. The brush assembly rotates about its

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1 longitudinal axis, whereby the brushes direct particles from a carpet or floor toward an
2 air stream flowing into inlet 37. The air stream carries the particles and flows from inlet
3 37 through head 38 into bag 34 (e.g., as indicated by the arrows in Fig. 5), whereby the
4 particles carried by the air stream are deposited within the bag collection chamber (not
5 shown). The collection chamber typically includes an air porous bag or plastic container
6 (not shown) that acts similar to a filter to permit an air stream to flow through the
7 collection chamber, while retaining particles carried by the air stream within the
8 collection chamber. Subsequent to flowing through the collection chamber, the air
9 stream traverses slots 35, typically defined in a side wall of bag 34 toward the bag rear
10 wall, to return to a surrounding environment.

11 An air purification system 50 may be disposed within bag 34 between the
12 collection chamber and slots 35 to purify an air stream prior to the air stream returning to
13 a surrounding environment. System 50 is typically substantially similar to the system
14 described above for Fig. 1, but may be implemented by any of the systems described
15 above or disclosed in the aforementioned patent applications that are capable of purifying
16 air. System 50 receives the air stream via an intake 31 and exposes the air stream to
17 ozone and germicidal radiation to remove contaminants from the air stream in
18 substantially the same manner described above. Purified air exits system 50 via an
19 exhaust vent 33, whereby the purified air traverses slots 35 of bag 34 to return to the
20 surrounding environment. Thus, upright vacuum cleaner 30 draws an air stream from the
21 surrounding environment into the vacuum cleaner to collect particles, while returning
22 purified air back to the surrounding environment.

23 Alternatively, system 50 may be employed by vacuum cleaners of the type having
24 a separate cleaning unit attached to a base and handle as illustrated in Fig. 6.
25 Specifically, a conventional vacuum cleaner 40 generally includes a cleaning unit 41,
26 typically housing a motor (not shown), and collection unit 47, typically including a base
27 42 and a handle 44. The vacuum cleaner motor draws an air stream into base 42 via an
28 inlet 46 disposed toward the front bottom portion of the base. Base 42 typically includes
29 a substantially cylindrical brush assembly 48 having brushes disposed on its exterior

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1 surface. The brush assembly is disposed within inlet 46 and rotates about its longitudinal
2 axis, whereby the brushes direct particles from a carpet or floor toward an air stream
3 flowing into inlet 46. Handle 44 is attached to base 42 to enable manipulation of the base
4 over the carpet or floor, and is further connected to cleaning unit 41 via a hose 45. The
5 air stream carries the particles and flows from inlet 46 into base 42 and through handle 44
6 and hose 45 into a collection chamber (not shown) disposed within cleaning unit 41 (e.g.,
7 as indicated by the arrows in Fig. 6), whereby the particles carried by the air stream are
8 deposited within the collection chamber. The collection chamber typically includes an
9 air porous bag or plastic container (not shown) that acts similar to a filter to permit an air
10 stream to flow through the collection chamber, while retaining particles carried by the air
11 stream within the collection chamber. Subsequent to flowing through the collection
12 chamber, the air stream traverses slots 43, defined toward a rear portion of the cleaning
13 unit housing, to return to a surrounding environment.

14 An air purification system 50, substantially similar to the system described above
15 for Fig. 5, may be disposed within cleaning unit 41 between the collection chamber and
16 slots 43 of cleaning unit 41 to purify an air stream prior to the air stream returning to a
17 surrounding environment. System 50 receives the air stream via an intake 31 and
18 exposes the air stream to ozone and germicidal radiation to remove contaminants from
19 the air stream in substantially the same manner described above. Purified air exits
20 system 50 via an exhaust vent 33, whereby the purified air traverses slots 43 to return to
21 the surrounding environment as described above. System 50 may be disposed in any
22 type of vacuum cleaner, including vacuum cleaners having soft bags, at any location
23 along an air flow path to purify an air stream within the vacuum cleaner. Further, system
24 50 may be disposed in any appliance at any location along an air flow path to enable the
25 appliance to return purified air to a surrounding environment in substantially the same
26 manner described above.

27 It will be appreciated that the embodiments described above and illustrated in the
28 drawings represent only a few of the many ways of implementing a method and
29 apparatus for purifying appliance exhaust and removing contaminants from objects.

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1 The ballasts for the radiation sources of the systems described above may be
2 implemented by any conventional DC (e.g., for portable systems) or AC ballast or other
3 circuitry to supply current to the radiation sources. The systems described above may be
4 of any shape or size, may be constructed of any suitable materials, and may include any
5 quantity of radiation sources (e.g., at least one) of any shapes or size disposed in any
6 manner within the systems. The internal fan of the systems described above may be
7 implemented by any quantity of any conventional or other types of fans or devices for
8 drawing air through a system, such as a fan, blower or device to create a differential
9 pressure in a system to cause air flow through that system. The fan or other devices may
10 be disposed internal or external of a system in any manner capable of directing air
11 through that system. Further, the fan or devices may include variable flow rates to cause
12 air to flow through a system at various rates. For example, larger areas may require
13 greater flow rates to enable air within these larger areas to be rapidly and efficiently
14 treated by a system. The components of the systems described above may be arranged in
15 any fashion.

16 The system for removing contaminants from objects may be of any shape or size,
17 and may accommodate various objects. The ozone chamber may include a portion of the
18 germicidal section of the radiation source to expose the object to germicidal radiation to
19 enhance removal of contaminants. The slots for receiving and exhausting air from the
20 system may be of any quantity (e.g., at least one) shape or size, and may be defined at
21 any suitable locations in any of the system housing walls. The combination radiation
22 source may include any proportion of ozone section to germicidal radiation section, may
23 be configured to emit radiation of any desired wavelengths, and may alternatively be
24 implemented by independent radiation sources disposed within the ozone and germicidal
25 chambers and emitting radiation of any desired wavelengths. Further, the combination
26 radiation source typically only operates when each section is operable to prevent ozone
27 generation without germicidal radiation to destroy the ozone. The chamber divider and
28 ozone and germicidal chambers may be arranged in any fashion within the system. The
29 receptacle may be formed of any porous material and may be disposed at any location

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1 within the ozone chamber. Moreover, the receptacle may enable the object to be partially
2 disposed in the germicidal chamber for exposure to germicidal radiation. The object may
3 alternatively be retained in the ozone and/or germicidal chambers via any suitable
4 receptacles, containers, securing mechanisms, or in any conventional or other manners
5 (e.g., resting on the ozone chamber floor). The ozone chamber may further include a
6 tortuous path as described above to enable the ozone to mix with the air. The ozone
7 and/or germicidal chambers may include any quantity of receptacles arranged in any
8 fashion to expose various quantities of objects to ozone and/or germicidal radiation. The
9 ozone and germicidal chambers may include any suitable configurations to treat the air
10 stream, such as the configurations described above or disclosed in the above-mentioned
11 patent applications. The system may include any quantity (e.g., at least one) of ozone and
12 germicidal chambers each having a suitable configuration to treat the object and/or air.
13 In addition, the system may include a single chamber exposing the object and air to
14 ozone and germicidal radiation.

15 The system for removing contaminants from hands may be of any shape or size,
16 may be programmed to treat the hands for any desired time intervals, and may include
17 any quantity (e.g., at least one) of combination or independent radiation sources of any
18 shape or size disposed and/or arranged within the system in any fashion. The
19 combination radiation sources may include any proportion of ozone section to germicidal
20 radiation section, while the combination and independent radiation sources may be
21 configured to emit radiation of any desired wavelengths. The combination radiation
22 source enables simultaneous application of ozone and germicidal radiation to the hands
23 for a predetermined time interval, and typically only operates when each section is
24 operable to prevent ozone generation without germicidal radiation to destroy the ozone.
25 The system may further treat objects inserted into the treatment chamber in substantially
26 the same manner described above. The system may include any quantity of openings
27 (e.g., at least one) to accommodate any quantity of hands during a treatment cycle. The
28 openings defined in the system housing may be of any shape or size, and may be defined
29 at any suitable locations in any of the system housing walls. The openings may include

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1 any quantity (e.g., at least one) of flaps, or other devices to maintain ozone and radiation
2 within the system. The soaking, ozone and germicidal chambers may include any
3 suitable configurations to treat the air stream, such as the configurations described above
4 or disclosed in the above-mentioned patent applications. Further, the soaking chamber
5 path may include any path or other configuration capable of reducing air through-flow
6 velocity and enabling the ozone to mix and interact with the air. A path of this type may
7 be similarly disposed in the ozone and germicidal chambers. The system may include
8 any conventional or other control pad and processor or control circuitry to control system
9 operation as described above.

10 The air purification system may be of any size or shape, and may be disposed at
11 any location within any appliance or other device exhausting an air stream (e.g., vacuum
12 cleaner, blender, mixer, computer, etc.). The air purification system may be implemented
13 by any of the systems described above or disclosed in the above-mentioned patent
14 applications capable of purifying air. The air purification system may include a catalytic
15 converter or other filter disposed adjacent the germicidal chamber to remove residual
16 ozone from the air stream. The system may include any quantity (e.g., at least one) of
17 ozone and germicidal chambers, whereby each chamber may have any suitable
18 configuration, shape or size to treat air. Further, the system may include a single
19 chamber exposing the air stream to ozone and germicidal radiation. Moreover, the
20 system may utilize any quantity (e.g., at least one) of independent radiation sources of
21 any shape or size within each chamber, or any quantity (e.g., at least one) of combination
22 radiation sources of any shape or size having a plurality of sections with each section
23 disposed in and emitting radiation at an appropriate wavelength for a corresponding
24 chamber. The combination radiation source may include any proportion of ozone section
25 to germicidal radiation section, while the combination and independent radiation sources
26 may be disposed within the system in any fashion and be configured to emit radiation of
27 any desired wavelengths. The combination radiation source typically only operates when
28 each section is operable to prevent ozone generation without germicidal radiation to
29 destroy the ozone. The air flow path within the system ozone chamber may include any

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1 path or other configuration capable of reducing air through-flow velocity and enabling
2 the ozone to mix and interact with the air. A path of this type may similarly be disposed
3 within the germicidal chamber. The system intake and exhaust may be disposed on the
4 system in any fashion to accommodate a device air flow, while the air flow may enable
5 air to traverse the system without use or inclusion of a system fan.

6 It is to be understood that the present invention is not limited to the specific
7 embodiments discussed herein, but may be implemented in any manner that utilizes
8 ozone generation via a configuration that reduces air through-flow velocity to enable the
9 ozone to interact with the air (e.g., any path configuration or other mechanism to reduce
10 air through-flow velocity), and germicidal radiation to remove contaminants. Further, the
11 present invention is not limited to the specific applications disclosed herein, but rather,
12 may be utilized for any application employing or producing purified or ozone enriched
13 air.

14 From the foregoing description it will be appreciated that the invention makes
15 available a novel method and apparatus for purifying appliance exhaust and removing
16 contaminants from objects wherein air is exposed to UV radiation at a first wavelength to
17 generate ozone while traversing an ozone chamber configured to reduce air through-flow
18 velocity and to enhance ozone distribution in the air. The ozone oxidizes contaminants in
19 an air stream and/or object, whereby the air stream and/or object is subsequently exposed
20 to UV radiation at a second wavelength to remove bacteria and ozone therefrom.

21 Having described preferred embodiments of a new and improved method and
22 apparatus for purifying appliance exhaust and removing contaminants from objects, it is
23 believed that other modifications, variations and changes will be suggested to those
24 skilled in the art in view of the teachings set forth herein. It is therefore to be understood
25 that all such variations, modifications and changes are believed to fall within the scope of
26 the present invention as defined by the appended claims.

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WHAT IS CLAIMED IS:

- 1 1. A system for producing ozone enriched air to remove contaminants from objects
2 comprising:
3 an air intake to receive an air stream from a surrounding environment;
4 air flow control means for directing the air stream to flow through said system;
5 an ozone chamber having an ozone generating radiation source for irradiating the air
6 stream to produce ozone to remove contaminants from within the air stream resulting in an
7 ozonated air stream, and a receptacle for receiving and supporting an object within said ozone
8 chamber, wherein said receptacle is configured to enable the ozonated air stream to infiltrate said
9 receptacle and remove contaminants from said object;
10 a germicidal chamber for receiving said ozonated air stream from said receptacle within
11 said ozone chamber and including a germicidal radiation source for irradiating the ozonated air
12 stream to remove residual contaminants and at least a portion of ozone therefrom to produce
13 sterilized air; and
14 an exhaust for returning the sterilized air to the surrounding environment.
- 1 2. The system of claim 1 wherein said receptacle includes a porous material.
- 1 3. The system of claim 2 wherein said porous material includes mesh netting.
- 1 4. The system of claim 1 wherein said ozone generating radiation source and said
2 germicidal radiation source correspond to ozone and germicidal sections of a radiation bulb
3 emitting radiation having different wavelengths at different sections of said bulb.
- 1 5. A system for producing ozone enriched air to remove contaminants from objects
2 comprising:
3 an air intake to receive an air stream from a surrounding environment;
4 air flow control means to direct the air stream to flow through the system; and

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5 a treatment chamber including:
6 access means for facilitating placement and removal of an object within said
7 treatment chamber;
8 an ozone generating radiation source for irradiating the air stream to produce
9 ozone;
10 a soaking chamber disposed proximate said ozone generating radiation source and
11 including ozone distribution means for increasing residence time of said air stream in
12 said soaking chamber to enable the produced ozone to thoroughly mix and interact with
13 and ozonate the air stream, and guide means to direct said ozonated air stream toward
14 said object to interact with and remove contaminants from said object; and
15 a germicidal radiation source for irradiating the object to remove residual
16 contaminants and ozone therefrom.

1 6. The system of claim 5 wherein said ozone generating radiation source and said
2 germicidal radiation source are each independent radiation sources, and said system further
3 includes:

4 control means to enable said ozone generating radiation source for a first predetermined
5 time interval and enable said germicidal radiation source for a second predetermined time
6 interval;

7 wherein said control means enables said germicidal radiation source subsequent to
8 expiration of said first predetermined time interval.

1 7. The system of claim 5 wherein said object is a human hand.

1 8. In combination:

2 an electrical device performing a function other than purifying air and including air flow
3 means for facilitating an air flow from a surrounding environment through said electrical device;
4 and

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5 an air sterilizer for purifying air flowing within said electrical device, said air sterilizer
6 including:

7 an air intake to receive an air stream from within said electrical device;

8 an ozone chamber including an ozone generating radiation source for irradiating
9 the air stream to produce ozone to remove contaminants from within the air stream, and
10 ozone distribution means for reducing air stream through-flow velocity to increase
11 residence time of said air stream in said ozone chamber to enable the produced ozone to
12 thoroughly mix and interact with and ozonate the air stream and thereby enhance removal
13 of contaminants from within the air stream;

14 a germicidal chamber for receiving said air stream from said ozone chamber and
15 including a germicidal radiation source for irradiating the air stream to remove residual
16 contaminants and ozone therefrom; and

17 an exhaust to direct the air stream from said germicidal chamber to the electrical
18 device interior for return to the surrounding environment.

1 9. The combination of claim 8 wherein said electrical device includes a vacuum cleaner.

1 10. The combination of claim 8 wherein said electrical device includes a computer.

1 11. In an air sterilization system having an air intake, ozone and germicidal chambers,
2 and an exhaust, a method of producing ozone enriched air to remove contaminants from objects
3 comprising the steps of:

4 (a) receiving an air stream from a surrounding environment via the air intake;

5 (b) directing the air stream to flow through the system;

6 (c) placing an object within a receptacle disposed in the ozone chamber;

7 (d) irradiating the air stream within the ozone chamber via an ozone generating radiation
8 source to produce ozone to remove contaminants from within the air stream resulting in an
9 ozonated air stream;

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10 (e) configuring the receptacle to enable the ozonated air stream to infiltrate the
11 receptacle and remove contaminants from the object;

12 (f) irradiating the air stream received from the receptacle in the ozone chamber within
13 the germicidal chamber via a germicidal radiation source to remove residual contaminants and at
14 least a portion of ozone therefrom to produce sterilized air; and

15 (g) returning the sterilized air to a surrounding environment via the exhaust.

1 12. The method of claim 11 wherein step (e) further includes:

2 (e.1) configuring the receptacle to include a porous material to enable the ozonated air
3 stream to infiltrate the receptacle and remove contaminants from the object .

1 13. The method of claim 12 wherein step (e.1) further includes:

2 (e.1.1) configuring the receptacle to include mesh netting to enable the ozonated air
3 stream to infiltrate the receptacle and remove contaminants from the object.

1 14. In an air sterilization system having an air intake and a treatment chamber, a method
2 of producing ozone enriched air to remove contaminants from objects comprising the steps of:

3 (a) receiving an air stream from a surrounding environment via the air intake;

4 (b) directing the air stream to flow through the system;

5 (c) disposing an object within the treatment chamber;

6 (d) irradiating the air stream within the treatment chamber via an ozone generating
7 radiation source to produce ozone;

8 (e) increasing residence time of the air stream within a soaking chamber disposed
9 proximate the ozone generating radiation source to enable the produced ozone to thoroughly mix
10 and interact with and ozonate the air stream;

11 (f) directing the ozonated air stream toward the object to interact with and remove
12 contaminants from the object; and

13 (g) irradiating the object within the treatment chamber via a germicidal radiation source
14 to remove residual contaminants and ozone therefrom.

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1 15. The method of claim 14 wherein the ozone generating radiation source and
2 the germicidal radiation source are each independent radiation sources, wherein step (d)
3 further includes:

4 (d.1) enabling the ozone generating radiation source for a first predetermined
5 time interval; and

6 step (g) further includes:

7 (g.1) enabling the germicidal radiation source for a second predetermined time
8 interval subsequent to expiration of the first predetermined time interval.

1 16. The method of 14 wherein the object includes a human hand, and step (c)
2 further includes:

3 (c.1) inserting a user's hand within the treatment chamber.

1 17. A method of purifying air within an electrical device, wherein the electrical
2 device performs a function other than purifying air and includes air flow means to
3 facilitate an air flow through the device, said method comprising the step of disposing an
4 air sterilizer within the electrical device in the air flow path for exposing an air stream
5 within the electrical device to ozone and germicidal radiation to remove contaminants
6 residing in the air stream and directing sterilized air to the electrical device interior for
7 return to the surrounding environment.

1 18. The method of claim 17 wherein said electrical device includes a vacuum
2 cleaner.

1 19. The method of claim 17 wherein said electrical device includes a computer.

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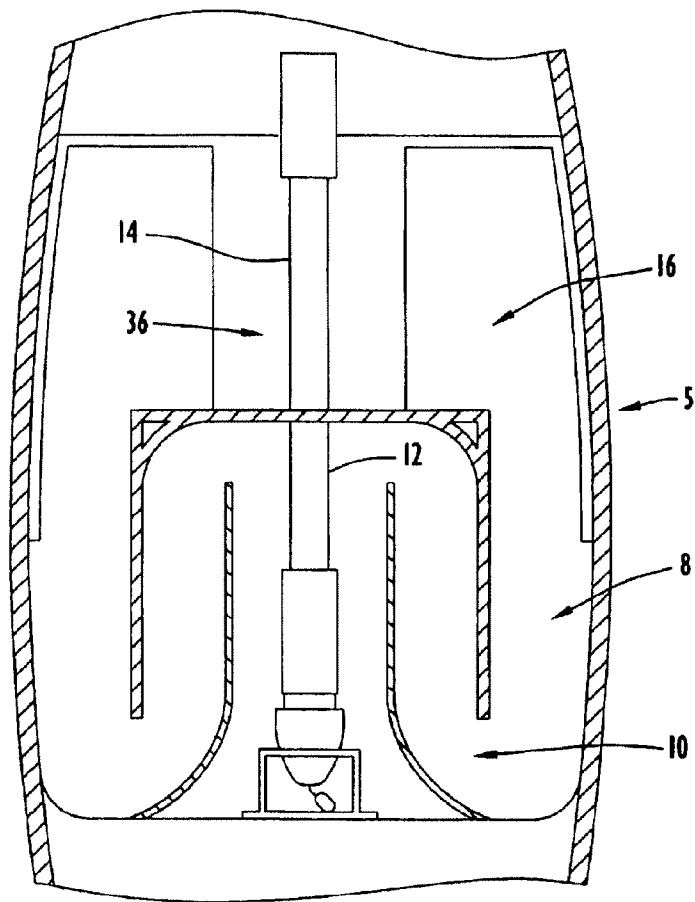
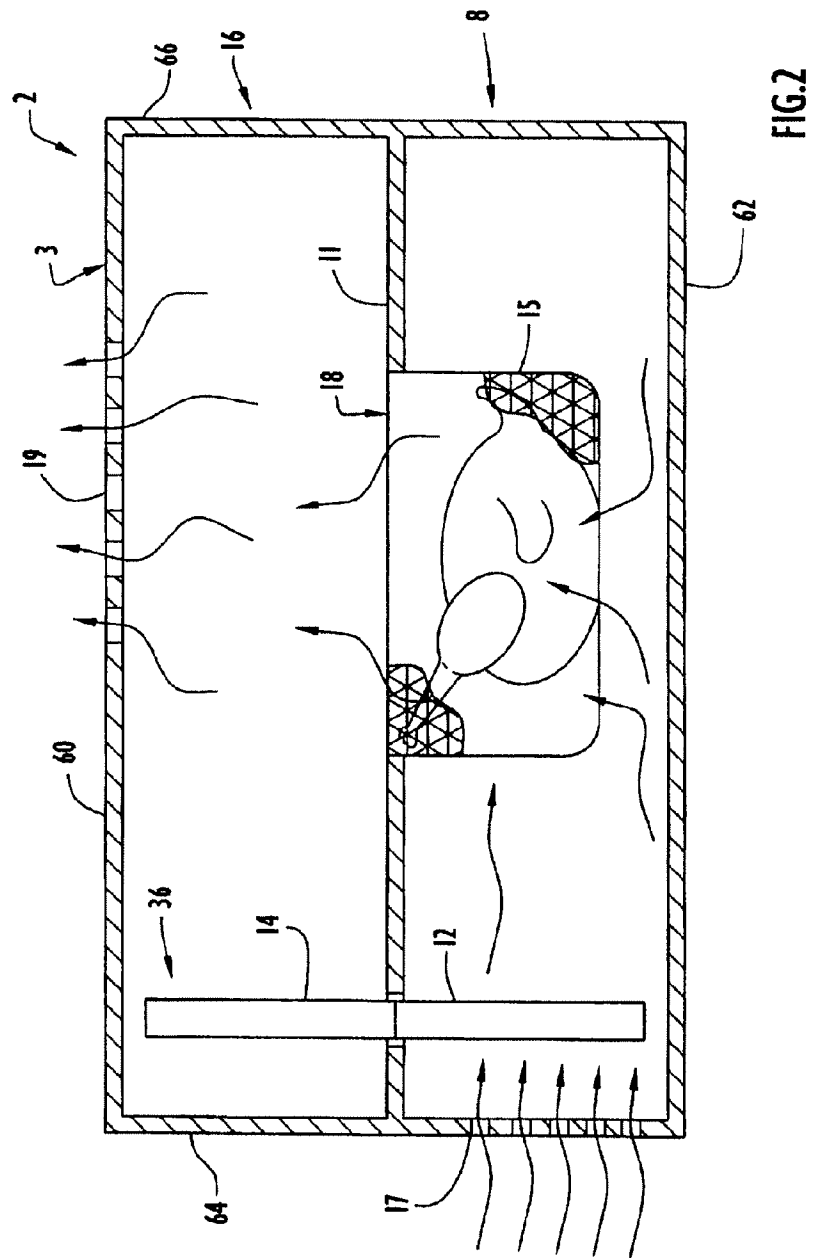


FIG.1



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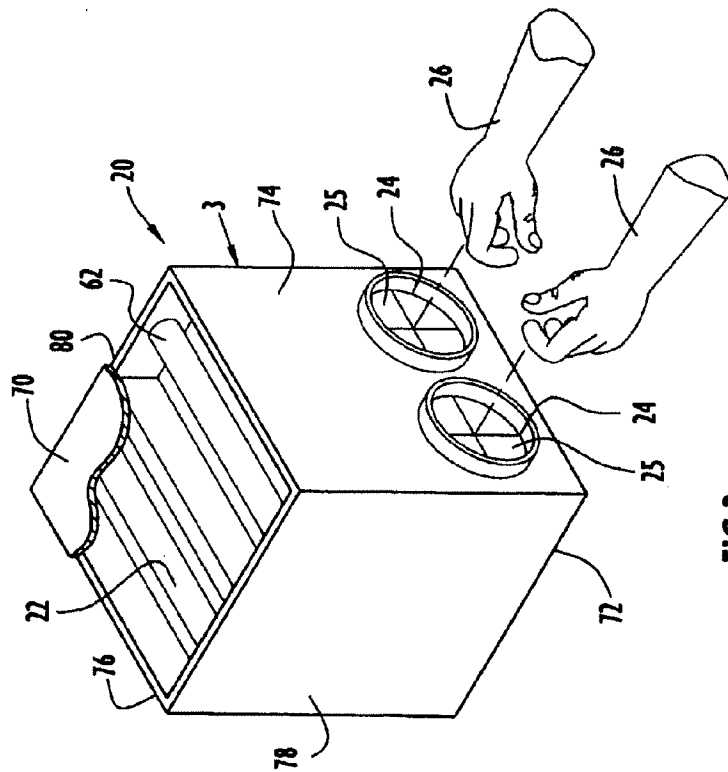


FIG. 3

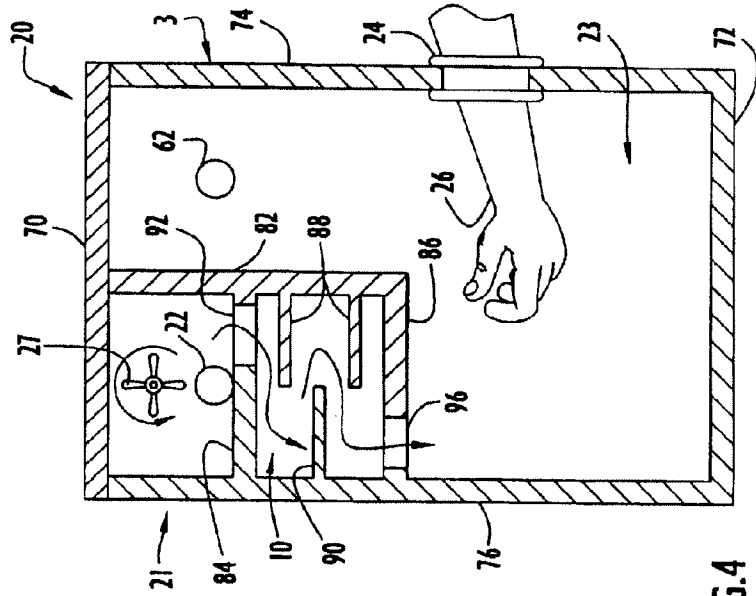


FIG. 4

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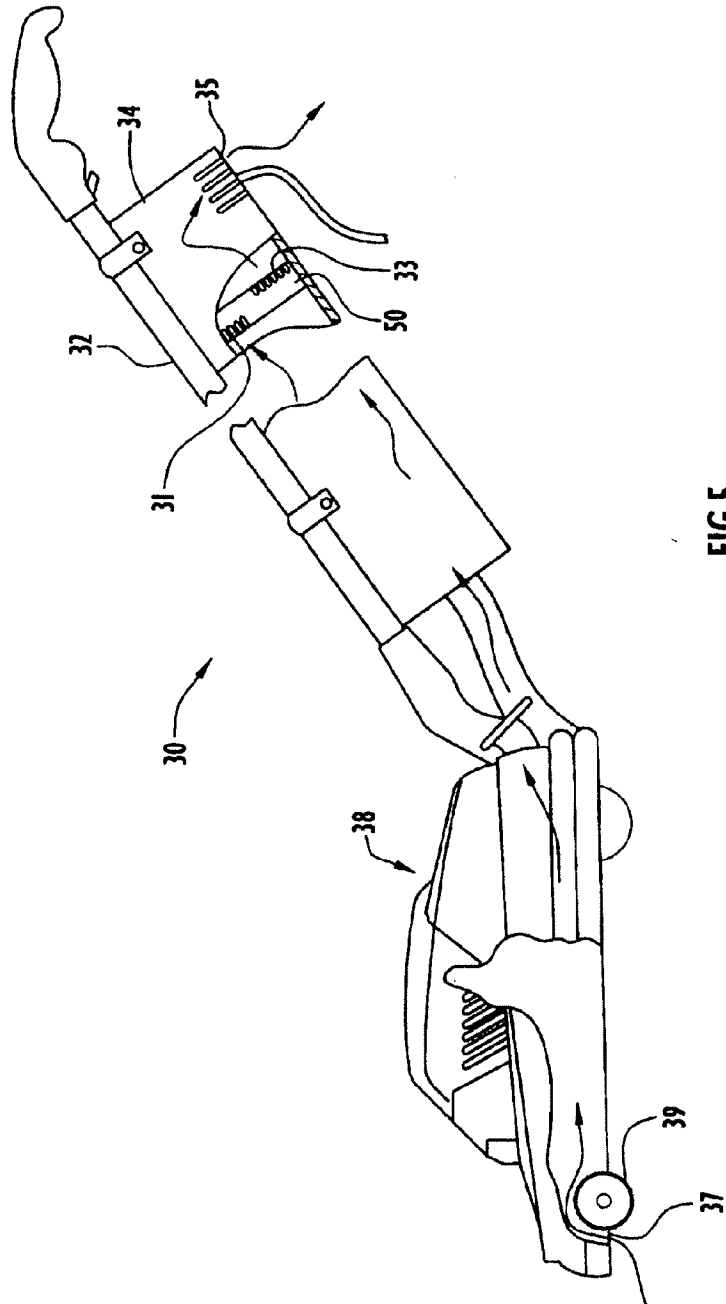


FIG. 5

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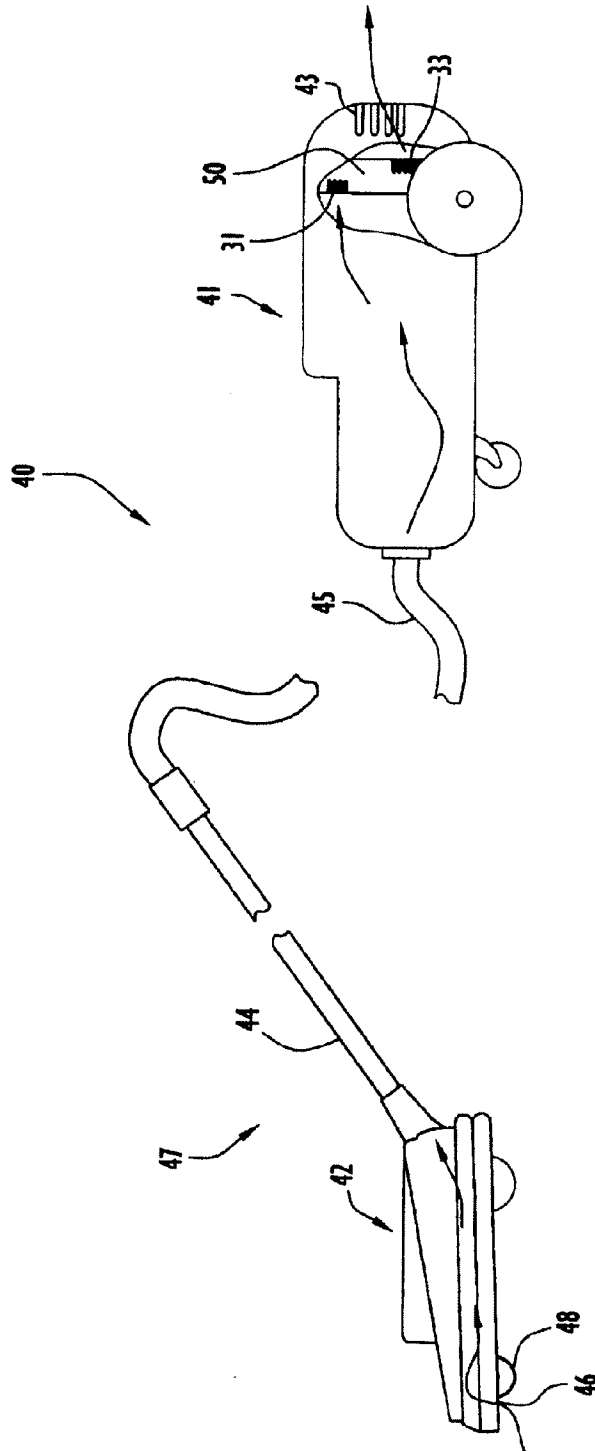


FIG. 6